Typical Cost Estimates

M-0446 Ramp Metering Feasibility Study for Durham and Wake Counties

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Introduction

This report presents typical ramp metering cost estimates for various alternative and optional features. The document describes the assumptions and unit costs used to develop the typical site costs.

For each typical ramp meter configuration, this report includes the site-specific capital costs associated with the following:

- Geometric construction
- Signal displays and supports
- Detection
- Controllers
- Signing
- Pavement markings

Separately, the report includes program costs—procurement and integration of the control software and the controller firmware, which are prorated per site. Training costs are included in the software costs as described in this report. Operations and maintenance costs have been estimated using information from other states.

These planning-level estimates will be used in the development of the Implementation Plan. The cost for a specific location will be developed from the typical cost estimate and customized for any site-specific conditions present at the location. Please note that these are general costs derived for the purpose of this study. Actual costs will vary based on the actual design and implementation of a ramp meter.

The Appendix contains the typical drawings from the Task 7 Typical Design Criteria Report, as well as additional detail of each cost category for each typical layout.

1. Typical Cost Methodology

Capital cost estimates are included for six basic ramp meter configurations. The costs of the following alternatives are presented in this report:

- Single-Lane Ramp Meter
- Single-Lane Ramp Meter (Loop Ramp)
- Two-Lane Ramp Meter
- Single-Lane Ramp Meter with Transit Bypass Lane
- Single-Lane Freeway-to-Freeway Ramp Meter
- Two-Lane Freeway-to-Freeway Ramp Meter

In addition, a separate capital cost estimate for optional enforcement features is included in this report. Each of the two optional features presented can be applied individually or together to any of the six basic ramp meter configurations. The optional enforcement features are: :

- Paved enforcement area
- Enforcement light

For each alternative, quantity estimates were made for each item of work. For each of these items of work, a planning level unit cost was applied, using NCDOT historical unit costs as a basis. In some cases, vendor quotes and data from other state DOTs were used. For each alternative, costs were applied for engineering design, traffic control, construction inspection, administration, and contingencies.

1.1. General Assumptions

For each estimate, certain basic assumptions must be made to produce a “typical” or generic cost estimate. When site-specific costs are developed, these assumptions will be refined on a site-by-site basis. Assumed quantities are shown in the tables documenting each alternative’s costs.

For each alternative the following basic design assumptions were made:

- Ramp meter controllers will be protected by guardrail by placing the controller behind either existing or new guardrail. Each site’s needs will be evaluated in the implementation plan.
- Where trunk fiber-optic communications to the State Traffic Operations Center (STOC) is assumed to exist along the corridor, drop cables are included in the costs from the trunk cable to the ramp meter site.
- Ramp detection, which uses inductive loops on the ramp, is shown in Figure C-1 and C-2. For two-lane ramp meters, the same detection layout is used in each lane.
- Mainline detection on the ramp is shown in Figure C-3. The upstream freeway detection site is assumed to be microwave detection with wireless (radio) communications to the ramp meter controller cabinet.
- Non-freeway-to-freeway signing and pavement markings are shown in Figures D-1 and D-2.

- Freeway-to-freeway signing and pavement markings are shown in Figure D-3.
- Non-freeway-to-freeway ramps are assumed to have a 40-mph design speed. For loop ramps, a design speed of 30 mph is assumed. Based upon AASHTO standards, the formula for calculating taper length is:

  $L = WS^2/60$
  where L = taper length in feet,
  W is the transition width in feet,
  S is the speed in mph.

- Freeway-to-freeway ramps are assumed to have a 50-mph design speed. Based upon AASHTO standards, the formula for calculating taper length is:

  $L = WS$
  where L = taper length in feet,
  W is the transition width in feet,
  S is the speed in mph.

1.2. Single-Lane Ramp Meter

The geometric layout of the single-lane ramp meter alternative is shown in Figure A-1. This alternative assumes there is no pavement widening, that the typical 16-foot-wide ramp lane is narrowed to 12 feet, and that 12 foot width is maintained for 100 feet upstream of the ramp meter. The transition tapers are 110 feet long for a 40-mph design speed.

Signal heads are pedestal-mounted with breakaway pedestals. Guardrail with approach end treatment on one side of the ramp is included to protect the ramp meter cabinet and pedestal pole.

For the single-lane ramp meter typical layout, costs are estimated as shown in Table 1.

Table 1. Typical Single-Lane Ramp Meter Construction Costs

Categories		Total Cost
Earthwork and Structures		$ 3,998
Guardrail		$ 5,250
Drainage		$ -
Signalization		$ 58,307
Communications		$ 7,400
Pavement Marking		$ 1,089
Signing		$ 2,300
Subtotal Construction (rounded)		**$ 78,350**
Traffic Control	3%	$ 3,000
Contingencies	10%	$ 8,000
Construction (rounded)		**$ 89,350**
Design	8%	$ 8,000
Construction Administration	10%	$ 9,000
Total Design and Construction		**$ 106,350**

1.3. Single-Lane Loop Ramp Meter

The geometric layout of the loop ramp alternative is shown in Figure D-2. The ramp meter on a loop ramp varies from the single-lane alternative in the layout of advance signing and marking, due to the lower design speed and possible restricted sight distance.

This alternative assumes there is no pavement widening, that the typical 16-foot-wide ramp lane is narrowed to 12 feet, and that 12 foot width is maintained for 100 feet upstream of the ramp meter. The transition tapers are 60 feet long for a 30-mph design speed.

Signal heads are pedestal-mounted with breakaway pedestals. Guardrail with approach end treatment on one side of the ramp is included to protect the ramp meter cabinet and pedestal pole.

For the single-lane loop ramp typical meter layout, the costs are estimated as shown in Table 2.

Table 2. Typical Single-Lane Loop Ramp Meter Construction Costs

Categories		Total Cost
Earthwork and Structures		$ 3,998
Guardrail		$ 5,250
Drainage		$ -
Signalization		$ 58,307
Communications		$ 7,400
Pavement Marking		$ 775
Signing		$ 2,300
Subtotal Construction (rounded)		**$ 78,030**
Traffic Control	3%	$ 3,000
Contingencies	10%	$ 8,000
Construction (rounded)		**$ 89,030**
Design	8%	$ 8,000
Construction Administration	10%	$ 9,000
Total Design and Construction		**$ 106,030**

1.4. Two-Lane Ramp Meter

The geometric layout of this alternative is shown in Figure A-2. It is assumed the existing ramp has a 16-foot lane, so widening would be necessary (although it is a site-specific issue). For this report, it is assumed an existing 16-foot ramp with 4-foot paved shoulders will be widened to two 12-foot lanes with 4-foot paved shoulders. The total pavement width will be 32 feet, which results in a net of 8 feet of total widening, or 4 feet on each side of the existing ramp. The transition tapers are 110 feet long for symmetrical widening and a 40-mph design speed.

The ramp detection layout will use the same configuration in each lane as a single-lane ramp. Signal heads are pedestal-mounted with breakaway pedestals. Guardrail with approach end treatment on both sides of the ramp is included to protect the ramp meter cabinet and both pedestal poles.

For the two-lane ramp typical meter layout, the costs are estimated as shown in Table 3.

Table 3. Typical Two-Lane Ramp Meter Construction Costs

Categories		Total Cost
Earthwork and Structures		$ 4,065
Guardrail		$ 10,500
Paving		$ 15,664
Drainage		$ -
Signalization		$ 61,778
Communications		$ 7,400
Pavement Marking		$ 1,149
Signing		$ 2,950
Subtotal Construction (rounded)		**$ 103,510**
Traffic Control	3%	$ 4,000
Contingencies	10%	$ 11,000
Construction (rounded)		**$ 118,510**
Design	8%	$ 10,000
Construction Administration	10%	$ 12,000
Total Design and Construction		**$ 140,510**

1.5. Single-Lane Ramp Meter with Transit Bypass Lane

The geometric layout of this alternative is shown in Figure A-3. To ensure drivers stay in their respective lanes, a 4-foot traffic separator between the lanes is required.

It is assumed the existing ramp has a 16-foot lane, so widening would likely be necessary (although it is a site-specific issue). It is further assumed an existing 16-foot ramp with 4-foot paved shoulders will be widened to two 12-foot lanes, 4-foot paved shoulders, and 4-foot traffic separator. There will be 1 foot between the traffic separator and each driving lane. The total pavement width is 38 feet, which results in a net of 14 feet of total widening, or 7 feet on each side of the existing ramp. The transition tapers are 190 feet long for symmetrical widening and a 40-mph design speed.

This alternative also differs from a single-lane ramp meter by having a different detection scheme in the second, or bypass, lane as shown in Figure C-2.

Guardrail with approach end treatment on both sides of the ramp is included to protect the ramp meter cabinet and both pedestal poles. Additional signing for the bypass lane and some changes in the pavement markings will be necessary.

For the single-lane ramp meter with transit bypass typical layout, the costs are estimated as shown in Table 4.

Table 4. Typical Single-Lane Ramp Meter with Transit Bypass Construction Costs

Categories		Total Cost
Earthwork and Structures		$ 4,400
Guardrail		$ 10,500
Paving		$ 33,812
Drainage		$ -
Signalization		$ 60,216
Communications		$ 7,400
Pavement Marking		$ 3,567
Signing		$ 3,850
Subtotal Construction (rounded)		**$ 123,750**
Traffic Control	3%	$ 4,000
Contingencies	10%	$ 13,000
Construction (rounded)		**$ 140,750**
Design	8%	$ 12,000
Construction Administration	10%	$ 15,000
Total Design and Construction		**$ 167,750**

1.6. Single-Lane Freeway-to-Freeway Ramp Meter

The geometric layout of this alternative is shown in Figure A-4. The basic layout assumes no widening is required. It is assumed the typical 16-foot-wide ramp lane is narrowed to 12 feet and that width is maintained for 100 feet. The transition tapers are 200 feet long for a 50-mph design speed.

Signal heads are mast-arm mounted and located outside the clear zone. Guardrail with approach end treatment on both sides of the ramp is included to protect the ramp meter cabinet, mast-arm pole, and two advance variable message sign (VMS) truss structures.

For the single-lane freeway-to-freeway ramp meter typical layout, the costs are estimated as shown in Table 5.

Table 5. Typical Single-Lane Freeway-to-Freeway Ramp Meter Construction Costs

Categories		Total Cost
Earthwork and Structures		$ 5,305
Guardrail		$ 31,500
Paving		$ -
Drainage		$ -
Signalization		$ 82,779
Communications		$ 7,400
Pavement Marking		$ 1,654
Signing		$ 112,300
Subtotal Construction (rounded)		**$ 240,940**
Traffic Control	3%	$ 8,000
Contingencies	10%	$ 25,000
Construction (rounded)		**$ 273,940**
Design	8%	$ 22,000
Construction Administration	10%	$ 28,000
Total Design and Construction		**$ 323,940**

1.7. Two-Lane Freeway-to-Freeway Ramp Meter

The geometric layout of this alternative is shown in Figure A-5. It is assumed the existing ramp has a 16-foot lane so widening would be necessary though it will be a site-specific issue. For this report, it is assumed an existing 16-foot ramp with 4-foot paved shoulders will be widened to two 12-foot lanes with 4-foot paved shoulders. The total pavement width will be 32 feet, which results in a net of 8 feet of total widening, or 4 feet on each side of the existing ramp. The transition tapers are 200 feet long for symmetrical widening and a 50-mph design speed.

Guardrail with approach end treatment on both sides of the ramp is included to protect the ramp meter cabinet, mast arm pole, and two advance VMS sign truss structures.

For the two-lane freeway-to-freeway ramp meter typical layout, the costs are estimated as shown in Table 6.

Table 6. Typical Two-Lane Freeway-to-Freeway Ramp Meter Construction Costs

Categories		Total Cost
Earthwork and Structures		$ 5,638
Guardrail		$ 31,500
Paving		$ 15,664
Drainage		$ -
Signalization		$ 84,751
Communications		$ 7,400
Pavement Marking		$ 1,369
Signing		$ 113,600
Subtotal Construction (rounded)		**$ 259,930**
Traffic Control	3%	$ 8,000
Contingencies	10%	$ 26,000
Construction (rounded)		**$ 293,930**
Design	8%	$ 24,000
Construction Administration	10%	$ 30,000
Total Design and Construction		**$ 347,930**

1.8. Optional Enforcement Features

Optional enforcement features consist of a paved enforcement area and a downstream-facing enforcement light. These features may be included together or individually.

The geometric design of a paved enforcement area located downstream of the ramp meter is shown in Figure E-1. The paved enforcement parking area is 12 feet wide x 75 feet long, plus transition tapers on each end. The paved surface is approximately 188 square yards. A sign has been included to identify the area.

The enforcement light, also shown in Figure E-1, is an additional 12-inch red signal face facing downstream of the ramp meter, wired to be on at the same time the red indication is on for vehicles, so that a law enforcement officer can monitor when the ramp meter is red. No appreciable additional wiring is needed.

No guardrail costs are included for the paved enforcement area.

Costs for the typical layout that includes both optional enforcement features are estimated in Table 7. The cost of an optional paved enforcement area only (without the enforcement light) would not include the Signalization category. The cost of an optional enforcement light without a paved enforcement area would be the Signalization category only.

Table 7. Typical Optional Enforcement Features Construction Costs

Categories		Total Cost
Earthwork and Structures		$ 1,003
Guardrail		$ -
Paving		$ 6,016
Signalization		$ 528
Pavement Marking		$ 314
Signing		$ 650
Subtotal Construction (rounded)		**$ 8,510**
Traffic Control	3%	$ 1,000
Contingencies	10%	$ 1,000
Construction (rounded)		**$ 10,510**
Design	8%	$ 1,000
Construction Administration	10%	$ 2,000
Total Design and Construction		**$ 13,510**

2. Program Costs

Program costs include the central software, servers, central communications hardware, integration, training, and firmware costs including installation and calibration.

2.1. Central Program Costs

Central program costs consist of the central software, servers, communications hardware, integration, and training. FDOT, Kansas DOT, GDOT, and a ramp metering vendor provided costs of their ramp metering software. Costs include the queue management algorithms to minimize the potential for ramp queues to back up on the cross streets. Cost estimates are as follows:

Table 8. Program Costs

Description	Cost
Central Software	
Software and Installation	$135,000
Driver and Installation	$95,000
Integration	$110,000
Training	$20,000
Servers (2)	$20,000
Misc. Central Communications Hardware	$25,000
Total	**$405,000**

2.2. Firmware Costs

A vendor quote estimated the firmware the total cost for the controllers at $50,000 for all 22 sites. Firmware installation and setup is estimated to take 1 day, and calibration is estimated to require 2 days per site.

Table 9. Firmware Costs per Site

Description	Cost	Assumptions
Firmware	$2,273	
Installation	$ 1,000.00	
Calibration	$ 2,016.00	2 days per site
Total	**$ 5,300.00**	

2.3. Maintenance

Poles, cabinets, and other equipment for ramp meters have essentially the same maintenance cost as is found in a typical traffic signal. Kansas DOT and GDOT provided an estimate of their annual maintenance costs. Data available through project reports and evaluation studies provided additional data points, although many of those costs are unusually low and not well defined concerning what is or is not included, even after adjusting

to present-day costs. Based on an average of Kansas and GDOT's costs, the estimated cost of annual scheduled (preventative) maintenance and unscheduled repairs is $6,400 per site. This cost includes labor, equipment, and parts.

In addition, $24,000 per year has been included for software support on the advice of FDOT, Kansas DOT, and a ramp metering vendor.

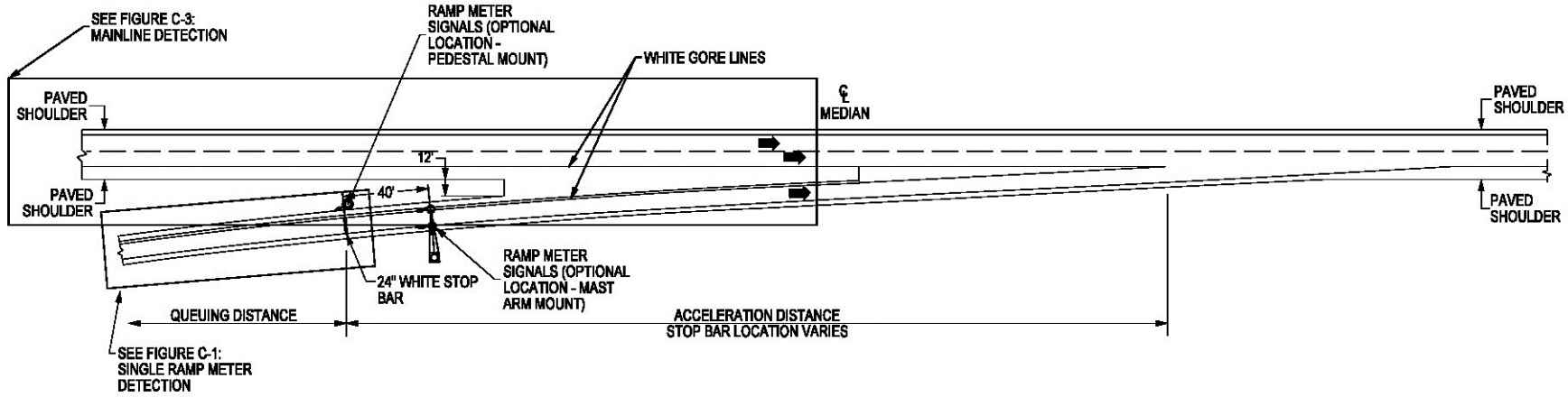
2.4. Operations

Operations costs consist of the cost to monitor the ramp meters from the STOC, respond to timing issues, and perform periodic adjustments in the operational parameters and management time. Based on information from Kansas DOT and GDOT, approximately 24 hours per site per year are spent monitoring and responding to timing type issues, which equates to:

2 engineers x 50,000/each/167 = $600 per site per year.

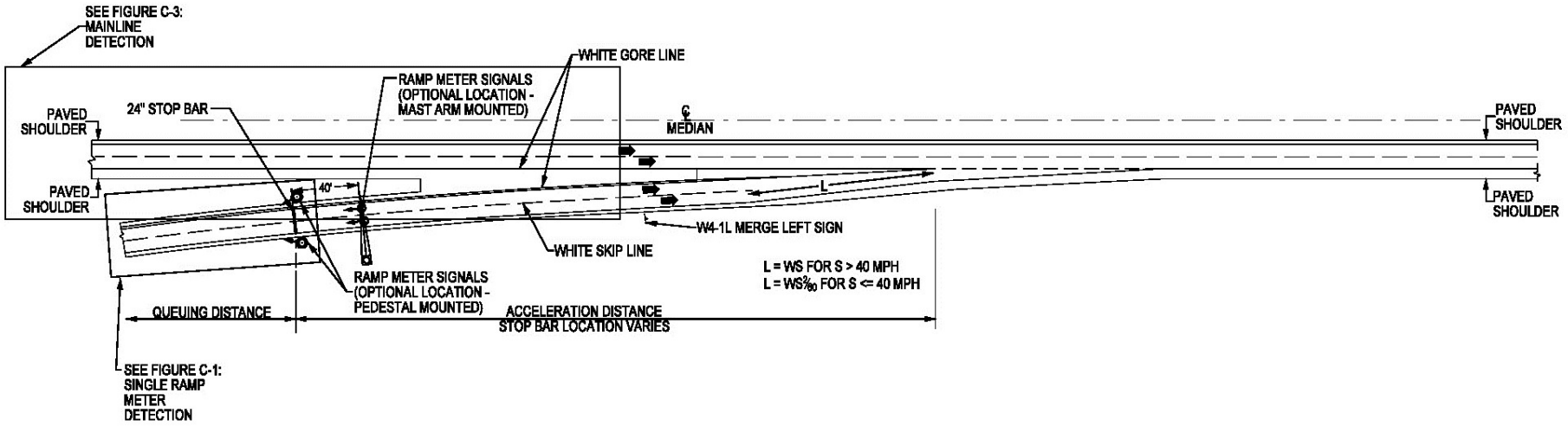
Appendices

Appendix A. Typical Ramp Meter Layouts



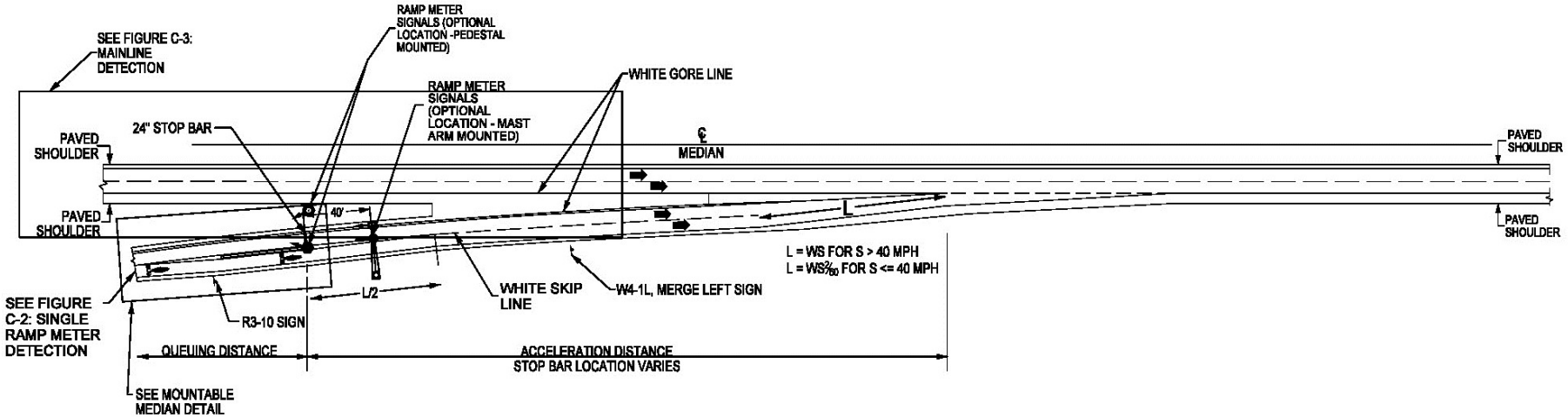
Notes
1. When truck volumes exceed 5% on 3% or greater ascending grades, provide 500' of auxiliary lane between the ramp meter stop bar and point where the ramp and mainline edges of pavement are 10' apart.
2. See AASHTO Exhibit 3-1 for acceleration distances.
3. Signal heads may be pedestal mounted or mast arm mounted as site conditions dictate.
4. See Figure B-1 for signalization and equipment.
5. See Figure C-1 for ramp meter detection.
6. See Figure C-3 for mainline detection.
7. See Figure D-1 for ramp meter signing and pavement markings.
8. See Figure D-2 for loop ramp signing and pavement markings.

Figure A-1: Single-Lane Ramp Meter Overview

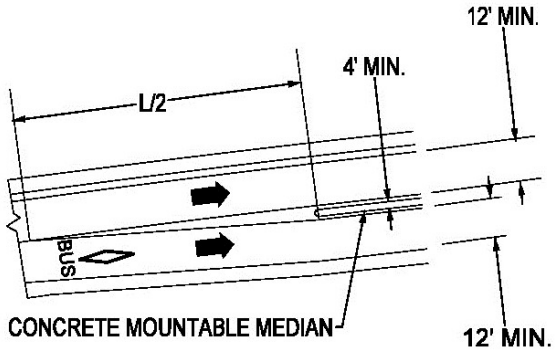


Notes
1. When truck volumes exceed 5% on 3% or greater ascending grades, provide 500' of auxiliary lane between the ramp meter stop bar and point where the ramp and mainline edges of pavement are 10' apart.
2. See AASHTO Exhibit 3-1 for acceleration distances.
3. Signal heads may be pedestal mounted or mast arm mounted as site conditions dictate.
4. Install W4-1L, merge left sign, in accordance with Table 2C-54 of the MUTCD.
5. See Figure B-1 for signalization and equipment.
6. See Figure C-1 for ramp meter detection.
7. See Figure C-3 for mainline detection.
8. See Figure D-1 for ramp meter signing and pavement markings.

Figure A-2: Two-Lane Ramp Meter Overview

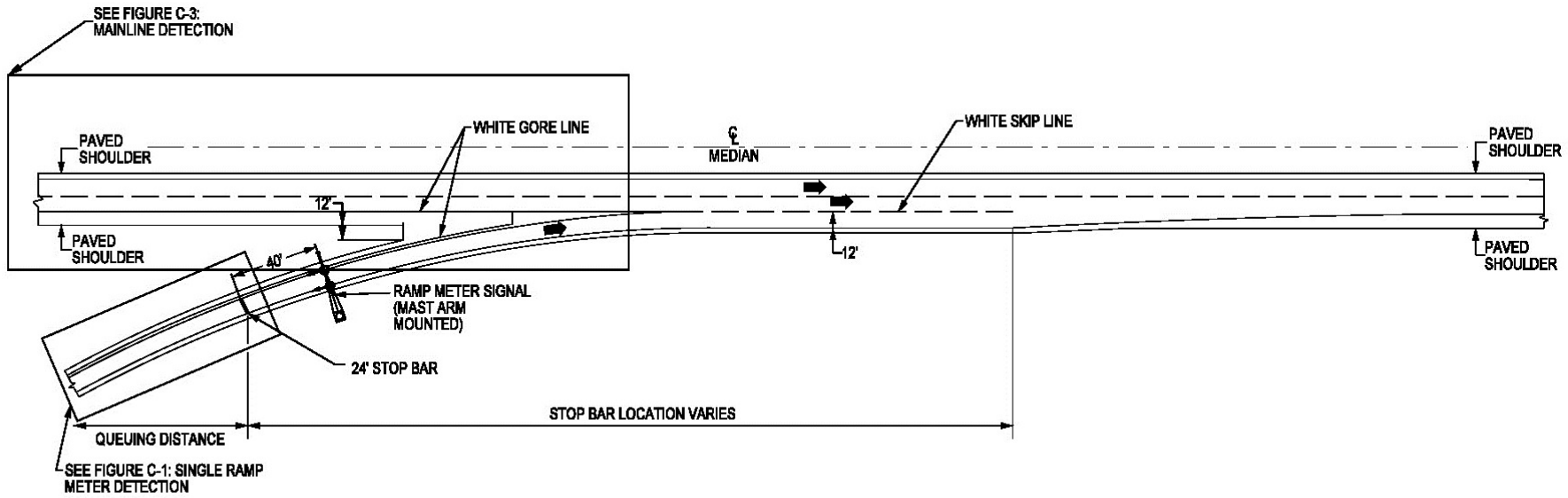


Notes
1. When truck volumes exceed 5% on 3% or greater ascending grades, provide 500' of auxiliary lane between the ramp meter stop bar and point where the ramp and mainline edges of pavement are 10' apart.
2. See AASHTO Exhibit 3-1 for acceleration distances.
3. mountable median should extend upstream at least 100' and desirable to the forecasted queue length
4. Minimum mountable median width is 4' with signal pedestal, minimum width is 2' without pedestal.
5. Signal heads may be pedestal mounted or mast arm mounted as site conditions dictate.
6. Install W4-1L, merge left sign, in accordance with Table 2C-54 of the MUTCD.
7. See Figure B-1 for signalization and equipment.
8. See Figure C-2 for ramp meter detection.
9. See Figure C-3 for mainline detection.
10. See Figure A-11 for ramp meter signing and pavement markings.



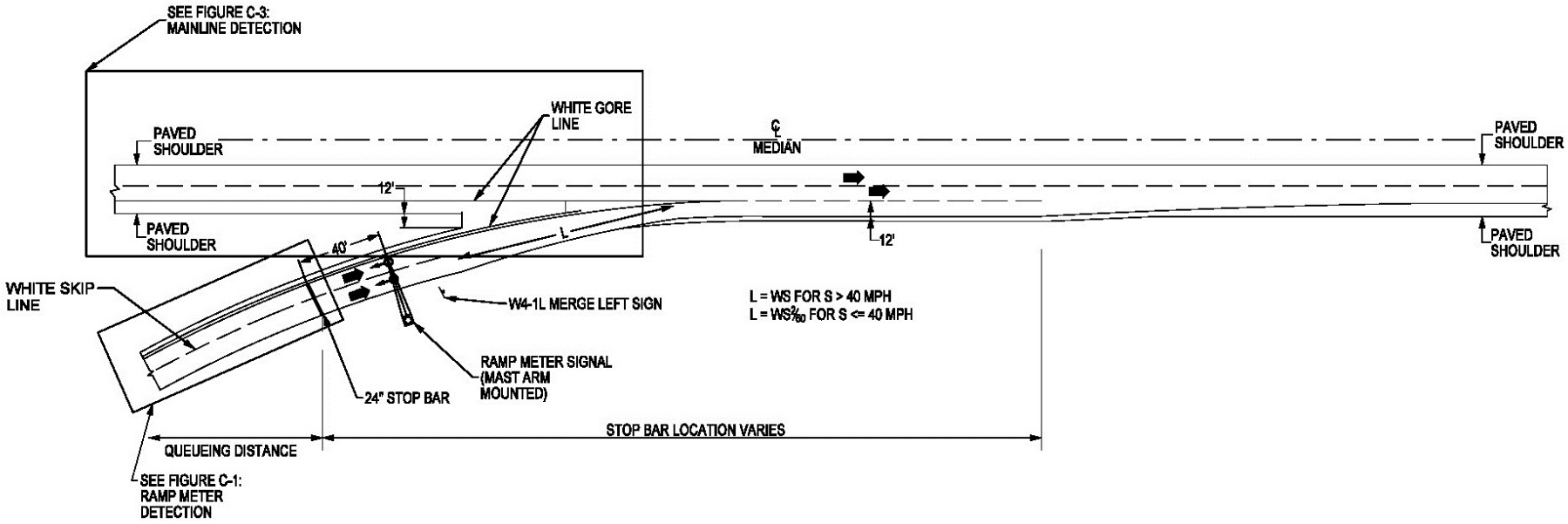
MOUNTABLE MEDIAN DETAIL

Figure A-3: Single-Lane Ramp Meter with Transit Bypass Overview



Notes
1. When truck volumes exceed 5% on 3% or greater ascending grades, provide 500' of auxiliary lane between the ramp meter stop bar and point where the ramp and mainline edges of pavement are 10' apart.
2. See AASHTO Exhibit 3-1 for acceleration distances.
3. Signal heads shall be mast arm mounted as site conditions dictate.
4. See Figure B-1 for signalization and equipment.
5. See Figure C-1 for ramp meter detection.
6. See Figure C-3 for mainline detection.
7. See Figures D-1 and D-3 for ramp meter signing and pavement markings.

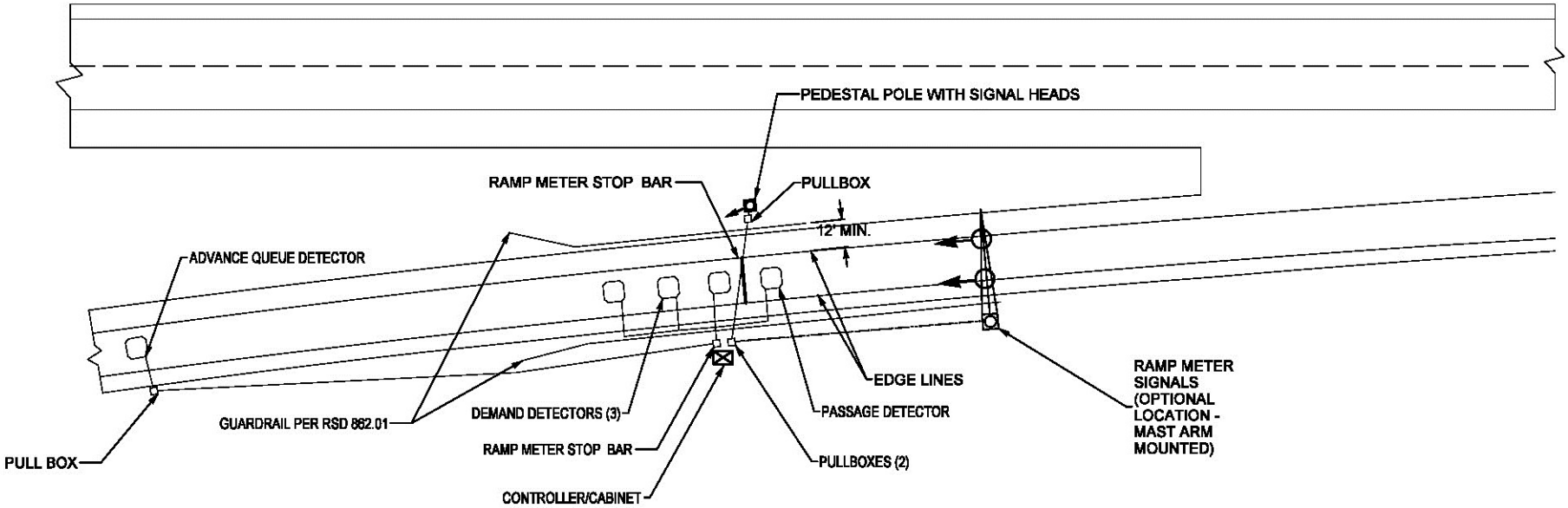
Figure A-4: Single-Lane Freeway to Freeway Ramp Meter Overview



Notes
1. When truck volumes exceed 5% on 3% or greater ascending grades, provide 500' of auxiliary lane between the ramp meter stop bar and point where the ramp and mainline edges of pavement are 10' apart.
2. See AASHTO Exhibit 3-1 for acceleration distances.
3. Signal heads shall be mast arm mounted as site conditions dictate.
4. Install W4-1L, merge left sign, in accordance with Table 2C-54 of the MUTCD.
5. See Figure B-1 for signalization and equipment.
6. See Figure C-1 for ramp meter detection.
7. See Figure C-3 for mainline detection.
8. See Figures D-1 and D-3 for ramp meter signing and pavement markings.

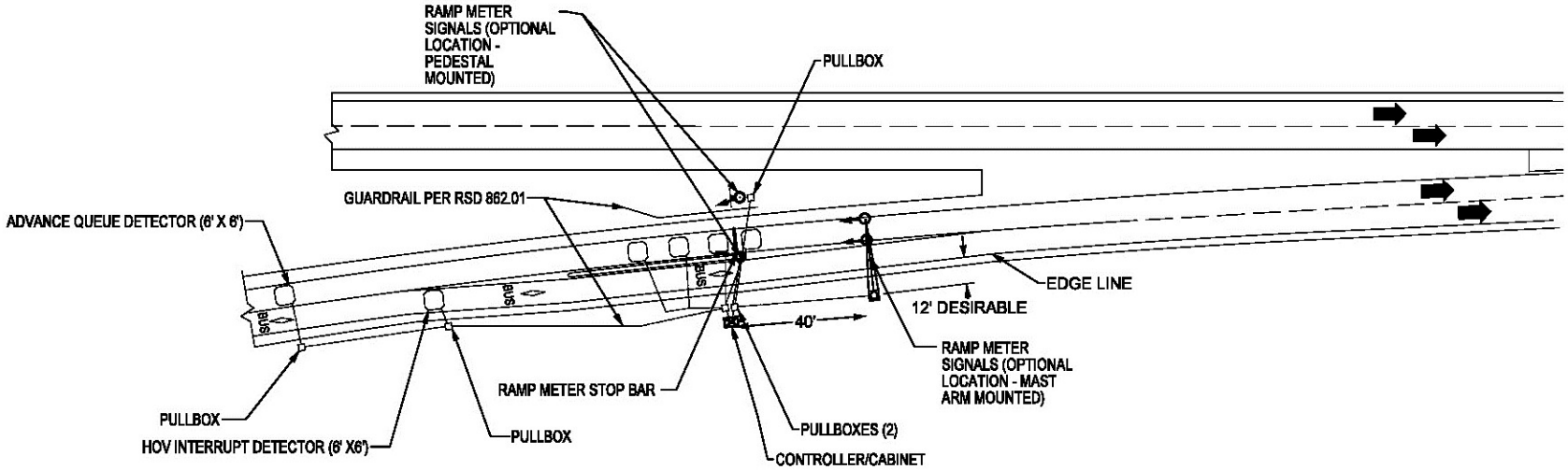
Figure A-5: Two-Lane Freeway to Freeway Ramp Meter Overview

Appendix B. Signal Head and Equipment Layouts



Notes
1. Use pedestal mounted signals only for single lane non-freeway to freeway ramp locations. Locate pedestal mounted signals to the left of the ramp and pointed towards the stop bar to minimize view from the mainline.
2. Use mast arm mounted signals only for freeway to freeway ramp locations.
3. Mast arm supports and controller cabinet may be on either side of ramp as site conditions dictate.
4. Protect signal pedestal and cabinet with guardrail or setback distance in accordance with clear zone standards.

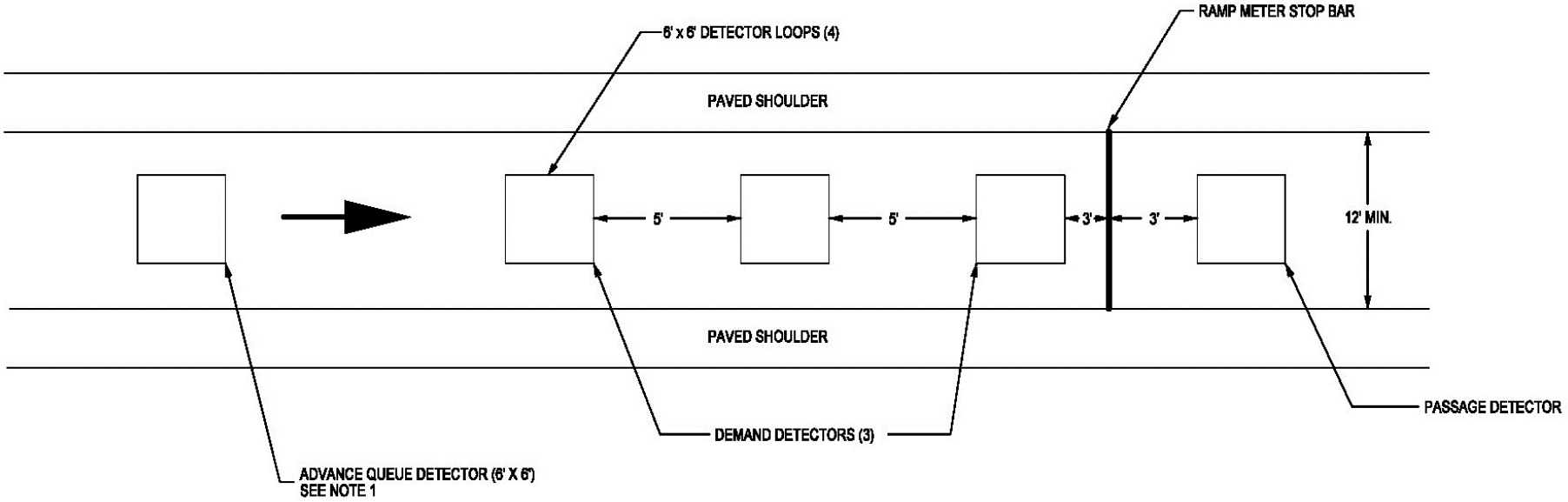
Figure B-1: Single-Lane Ramp Meter Signalization and Equipment Layout



Notes
1. Use pedestal mounted signals only for single lane non-freeway to freeway ramp locations.
2. Locate pedestal mounted signals to the left of the ramp and pointed towards the stop bar to minimize view from the mainline.
2. Protect signal pedestal and cabinet with guardrail or setback distance in accordance with clear zone standards.

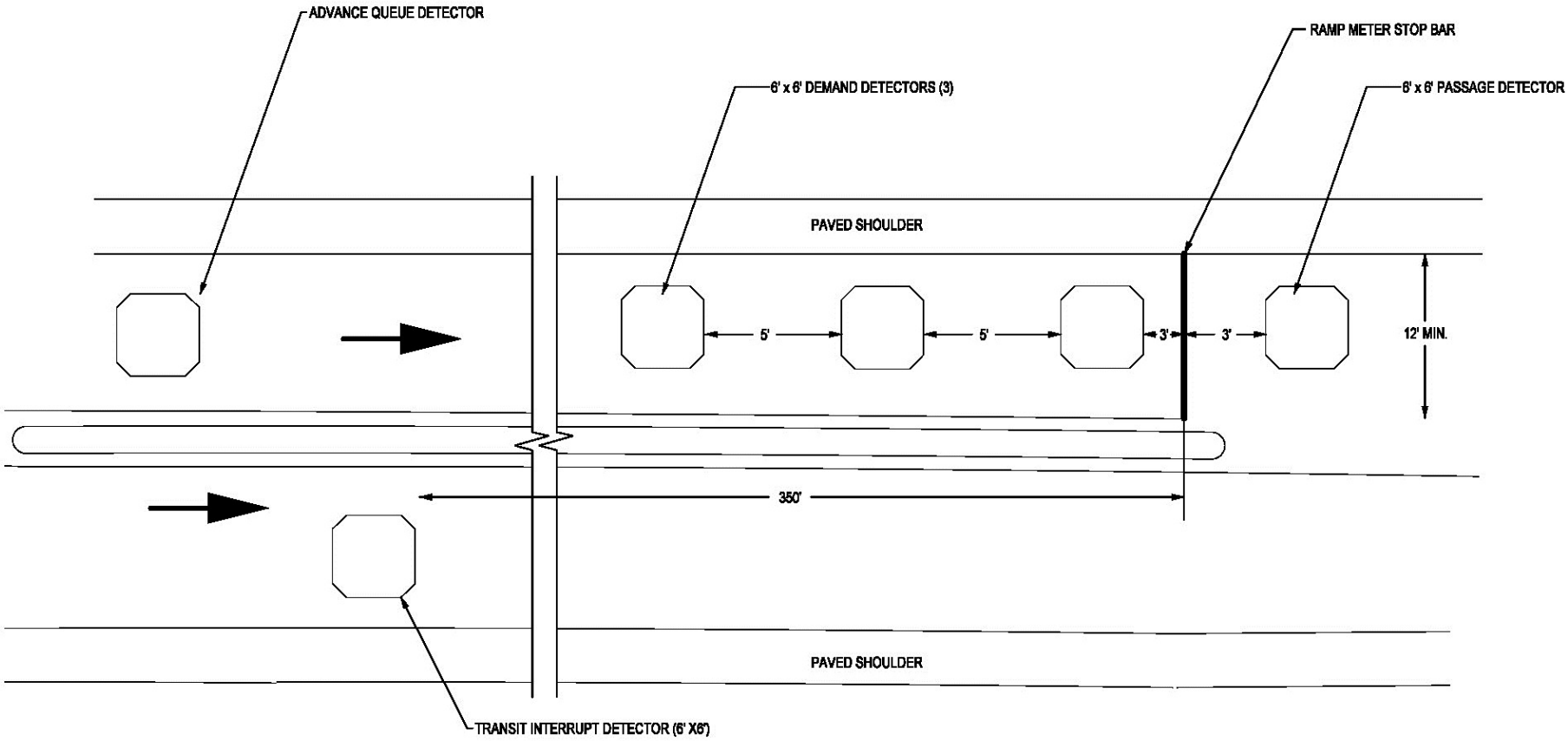
Figure B-2: Two-Lane Ramp Meter with Transit Bypass Signalization and Equipment Layout

Appendix C. Ramp and Mainline Detection Layouts



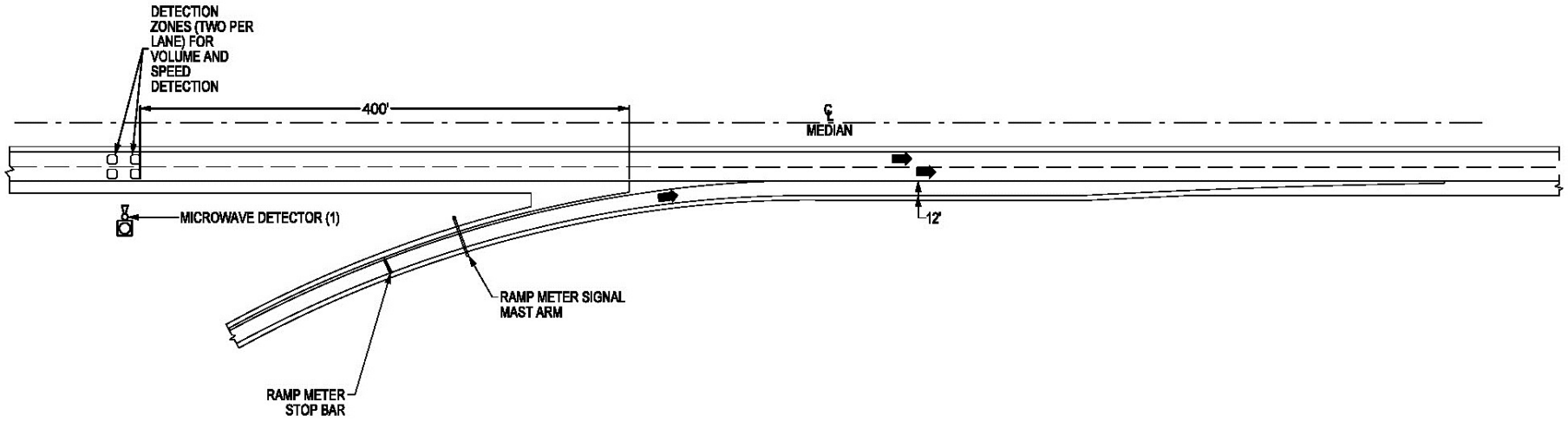
Notes
1. Place advance queue detector upstream of predicted queue per Table 4 but no more than 300 feet from the surface street intersection.
2. For dual lane ramp meter place detectors in second lane at same longitudinal spacing.
3. See Figure C-3 for mainline detection.

Figure C-1: Single-Lane Ramp Meter Detection



Notes
1. Place advance queue detector upstream of predicted queue per Table 4 but no more than 300 feet from the surface street intersection.
2. For dual lane ramp meter place detectors in second lane at same longitudinal spacing.
3. See Figure C-3 for mainline detection.

Figure C-2: Single-Lane Ramp Meter with Transit Bypass Detection



Notes
1. See Figures C-1 and C-2 ramp meter detection.
2. Install microwave detector(s) according to manufacturer's recommendations to avoid signal distortion due to bridges, sign structures, walls and barriers.
3. Adjust detector location as required by site conditions.

Figure C-3: Mainline Detection

Appendix D. Typical Ramp Meter Signing Layouts

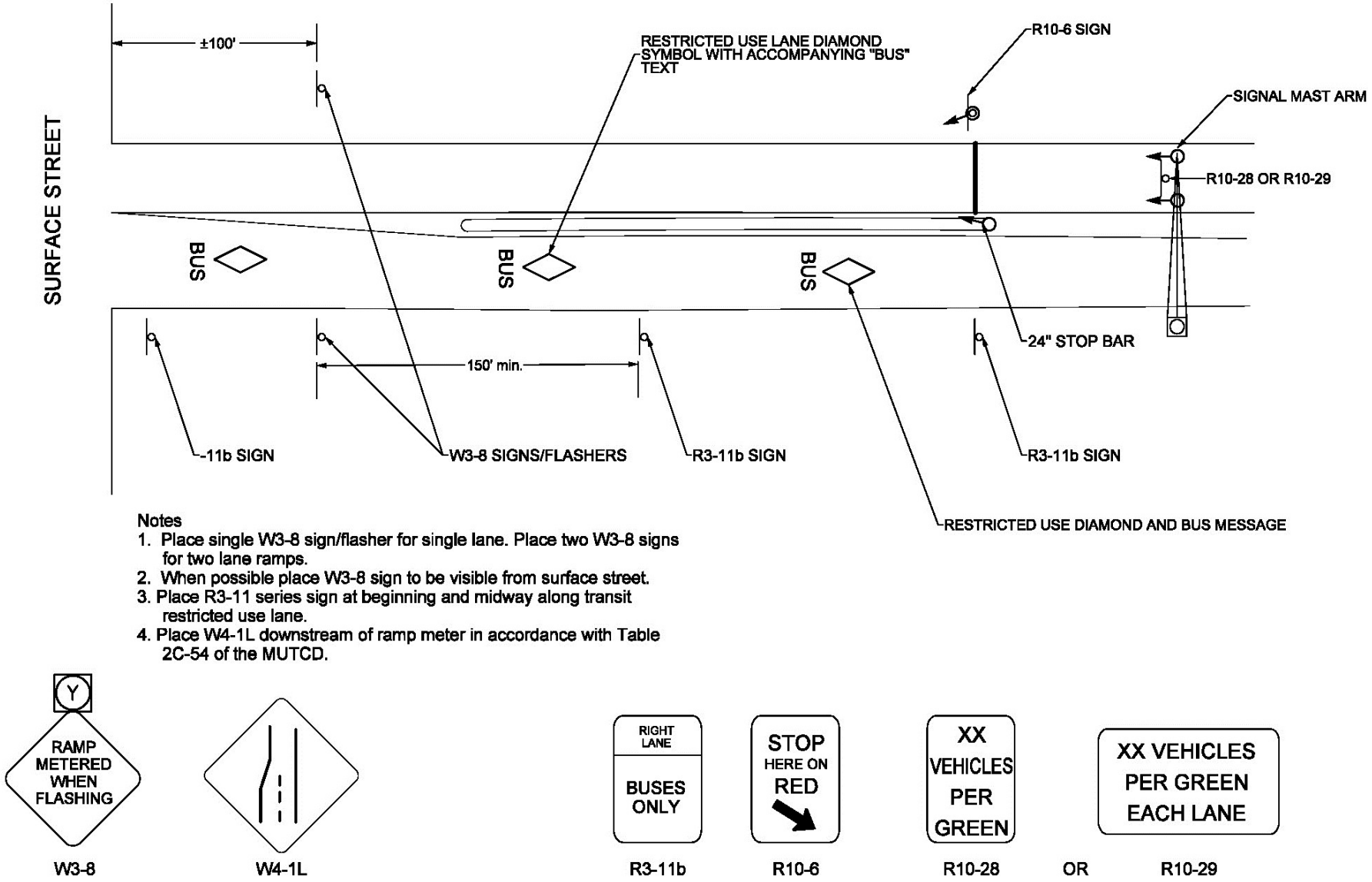
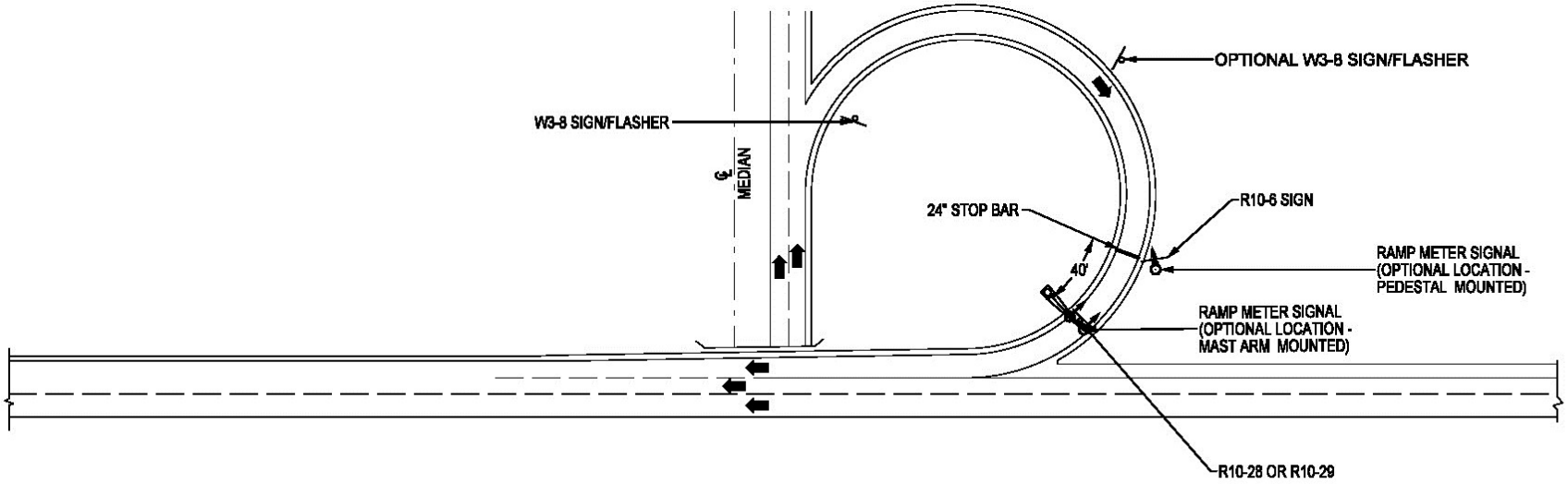


Figure D-1: Non-Freeway-to-Freeway Ramp Meter Signing and Pavement Markings



Notes
1. When truck volumes exceed 5% on 3% or greater ascending grades, provide 1000' of auxiliary lane between the ramp meter stop bar and point where the ramp and mainline edges of pavement are 10' apart.
2. Install additional W3-8 sign and flasher as necessary for locations where sight distance is limited.

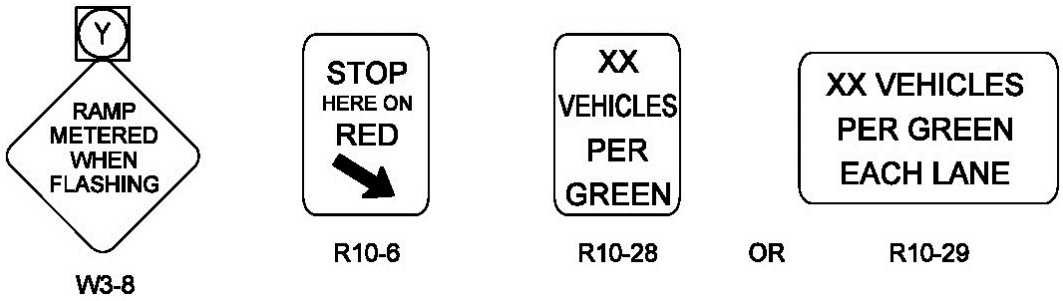
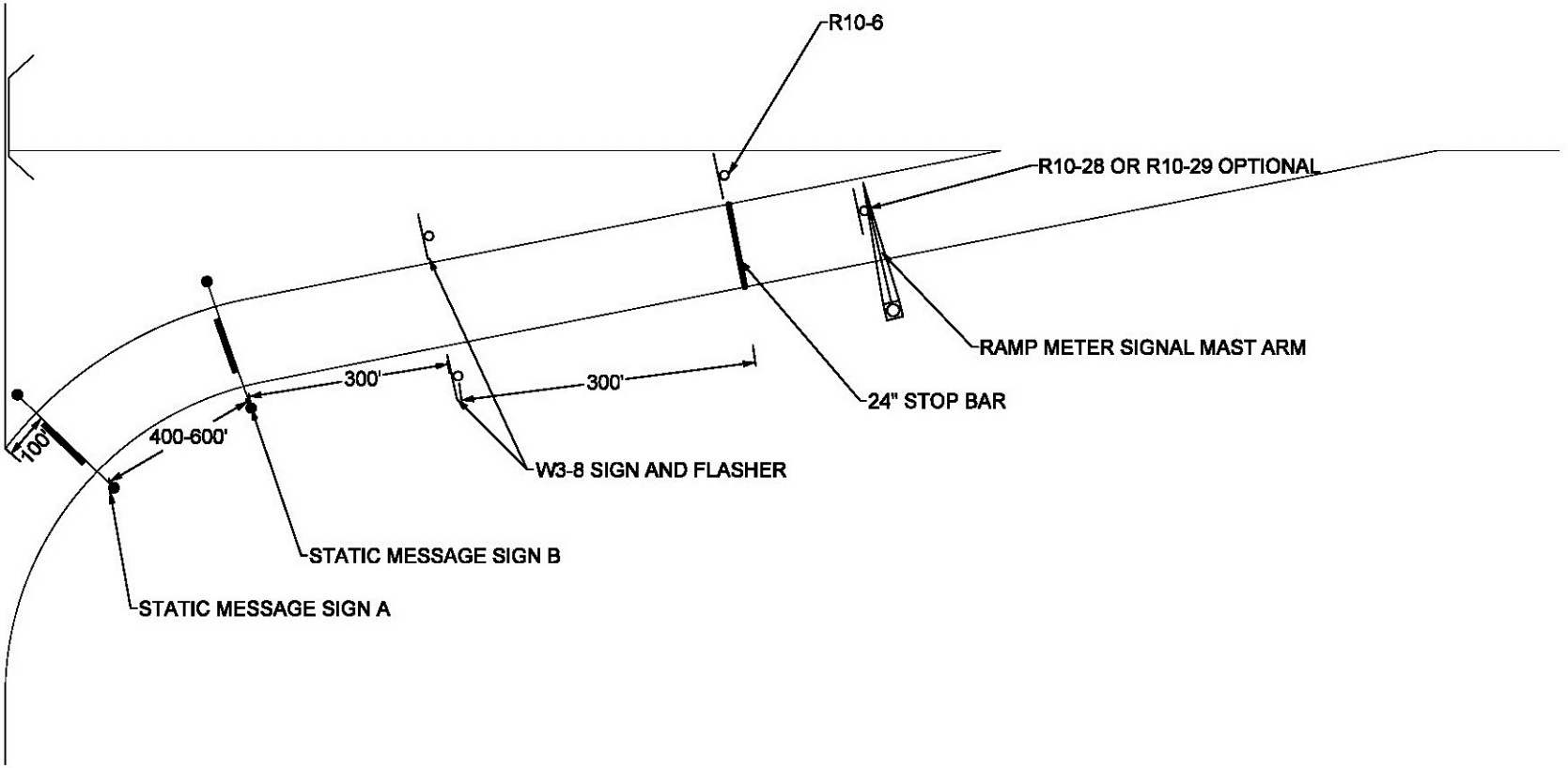
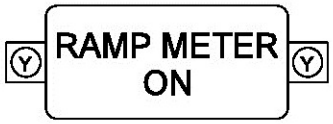


Figure D-2: Single-Lane Loop Ramp Meter Signing and Pavement Markings



Notes
1. See Figure D-2 for additional sign details.
2. Place single W3-8 sign/flasher for single lane. Place two W3-8 signs/flashers for two lane ramps.
3. When possible place W3-8 sign to be visible from surface street.

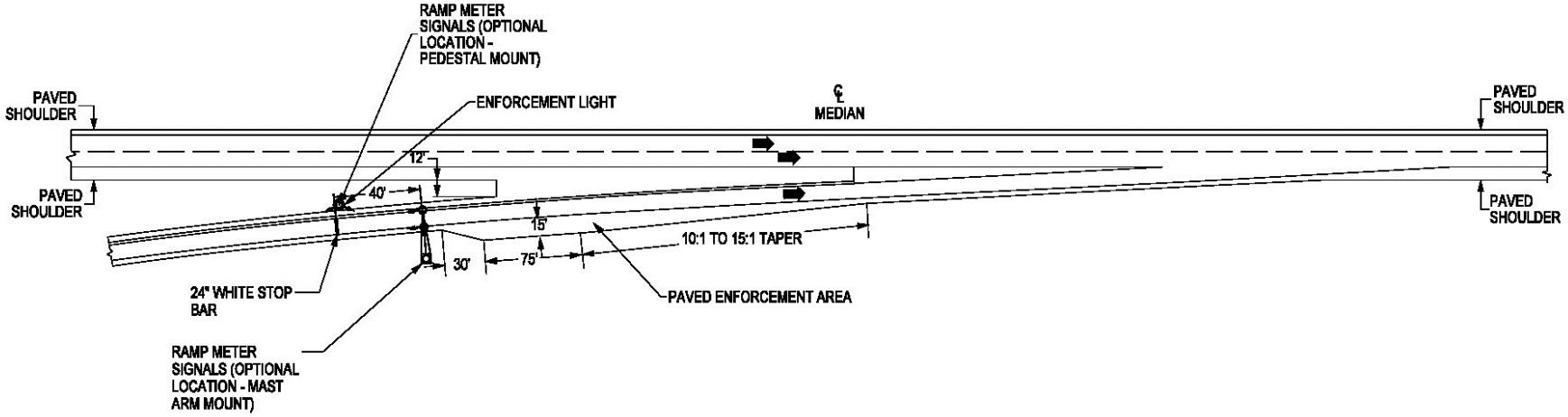
STATIC SIGN MESSAGE A



STATIC SIGN MESSAGE B

Figure D-3: Freeway-to-Freeway Ramp Meter Signing and Pavement Markings

Appendix E. Optional Enforcement Features



Notes
1. Begin taper to enforcement area 0-75' downstream of stop bar.
2. Dimensions may be adjusted to fit site conditions.
3. Enforcement areas are suitable locations having two metered lanes or one lane metered and one transit bypass lane.

Figure E-1: Optional Enforcement Features

Appendix F. Detailed Typical Cost Estimates

Table 10. Detailed Typical Single-Lane Ramp Meter Construction Costs

Categories / Description	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork and Structures					
Retaining Wall 5' High	LF	0	$ 250.00	$ -	
Retaining Wall 10' High	LF	0	$ 475.00	$ -	
Excavation	CY	0	$ 4.00	$ -	
Fill	CY	0	$ 5.00	$ -	
Seeding	SY	1599	$ 2.50	$ 3,997.50	Seeding around trench, conduit runs, pull box, and foundation areas
Subtotal				**$ 3,997.50**	
Guardrail					
Guardrail Rail	LF	250	$ 15.00	$ 3,750.00	
Guardrail Approach End Treatment	EA	1	$ 1,500.00	$ 1,500.00	
Subtotal				**$ 5,250.00**	
Drainage					
Pipe	LF	0	$ 44.00	$ -	
Subtotal				**$ -**	
Signalization					
6'x6' loops	EA	5	$ 394.50	$ 1,972.50	One queue, three passage and one clearance
Detector Lead-in Cable	EA	390	$ 1.50	$ 585.00	Assumed setback distance 350'
MVDS detector	EA	1	$ 1,800.00	$ 1,800.00	Mainline detection
Detector pole	EA	1	$ 6,000.00	$ 6,000.00	
Pullbox (Std.)	EA	6	$ 300.00	$ 1,800.00	
Conduit (Trenched)	LF	2350	$ 6.00	$ 14,100.00	All purposes
Conduit (Directional Drilled)	LF	50	$ 14.00	$ 700.00	One ramp crossing, multiple conduits
Electrical Service	EA	1	$ 1,500.00	$ 1,500.00	
Electrical Conductors	LF	1000	$ 5.00	$ 5,000.00	
2070 Controller and Cabinet	EA	1	$14,000.00	$ 14,000.00	
Firmware/Calibration	EA	1	$ 5,300.00	$ 5,300.00	
Cabinet Foundation	EA	1	$ 450.00	$ 450.00	
45' Mast Arm Poles and Foundation	EA	0	$15,000.00	$ -	
Pedestal Pole	EA	1	$ 1,000.00	$ 1,000.00	
Three Section Signal Head	EA	2	$ 1,000.00	$ 2,000.00	
One Section Signal Head	EA	2	$ 500.00	$ 1,000.00	Ramp meter advance signal
Signal Cable	LF	400	$ 2.75	$ 1,100.00	
Subtotal				**$ 58,307.50**	
Communications					
Serial Communications	EA	350	$ 2.00	$ 700.00	Link to MVDS
Splice Enclosure	EA	1	$ 1,000.00	$ 1,000.00	Link to SMFO
Pullbox (Special Size)	EA	1	$ 1,750.00	$ 1,750.00	For splice enclosure
Interconnect Center	EA	1	$ 1,500.00	$ 1,500.00	In cabinet
Fiber-optic Drop Cable (six strands)	LF	500	$ 1.50	$ 750.00	Drop cable to controller cabinet
Ethernet Switch	EA	1	$ 1,700.00	$ 1,700.00	
Subtotal				**$ 7,400.00**	

Pavement Marking					
Pavement Marking Removal	LF	640	$ 0.62	$ 396.80	40 mph design speed. 110' transitions, 100' narrowed lane
Raised Pavement Markers	EA	0	$ 4.50	$ -	
White Edge Line	LF	320	$ 0.95	$ 304.00	110' transitions, 100' narrowed lane
Yellow Edge Line	LF	320	$ 0.95	$ 304.00	110' transitions, 100' narrowed lane
24" Stop Bar	LF	12	$ 7.00	$ 84.00	
Subtotal				**$ 1,088.80**	
Signing					
W3-8, Ramp Metered When Flashing	EA	2	$ 650.00	$ 1,300.00	Sign and post only
W3-4, Be Prepared to Stop	EA	1	$ 650.00	$ 650.00	Sign and post
R10-6, Stop Here on Red	EA	1	$ 175.00	$ 175.00	Pedestal mounted
R10-28, XX Vehicles Per Green	EA	1	$ 175.00	$ 175.00	Pedestal mounted
Subtotal				**$ 2,300.00**	
Subtotal Construction (Rounded)				**$ 78,350.00**	
Traffic Control			3%	$ 3,000.00	
Contingencies			10%	$ 8,000.00	
Total Construction (Rounded)				**$ 89,350.00**	

Design	8%	$ 8,000.00
Construction Administration	10%	$ 9,000.00
Total Design and Construction		**$106,350.00**

Table 11. Detailed Typical Single-Lane Loop Ramp Meter Construction Costs

Categories / Description	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork and Structures					
Retaining Wall 5' High	LF	0	$ 250.00	$ -	
Retaining Wall 10' High	LF	0	$ 475.00	$ -	
Excavation	CY	0	$ 4.00	$ -	
Fill	CY	0	$ 5.00	$ -	
Seeding	SY	1599	$ 2.50	$ 3,997.50	Seeding around trench, conduit runs, pull box, and foundation areas
Subtotal				**$ 3,997.50**	
Guardrail					
Guardrail Rail	LF	250	$ 15.00	$ 3,750.00	
Guardrail Approach End Treatment	EA	1	$ 1,500.00	$ 1,500.00	
Subtotal				**$ 5,250.00**	
Drainage					
Pipe	LF	0	$ 44.00	$ -	
Subtotal				**$ -**	
Signalization					
6'x6' loops	EA	5	$ 394.50	$ 1,972.50	One queue, three passage and one clearance
Detector Lead-in Cable	EA	390	$ 1.50	$ 585.00	Assumed setback distance 350'
MVDS detector	EA	1	$ 1,800.00	$ 1,800.00	Mainline detection
Detector pole	EA	1	$ 6,000.00	$ 6,000.00	
Pullbox (Std.)	EA	6	$ 300.00	$ 1,800.00	
Conduit (Trenched)	LF	2350	$ 6.00	$ 14,100.00	All purposes
Conduit (Directional Drilled)	LF	50	$ 14.00	$ 700.00	One ramp crossing, mult. conduits
Electrical Service	EA	1	$ 1,500.00	$ 1,500.00	
Electrical Conductors	LF	1000	$ 5.00	$ 5,000.00	
2070 Controller and Cabinet	EA	1	$14,000.00	$ 14,000.00	
Firmware/Calibration	EA	1	$ 5,300.00	$ 5,300.00	
Cabinet Foundation	EA	1	$ 450.00	$ 450.00	
45' Mast Arm Poles and Foundation	EA	0	$15,000.00	$ -	
Pedestal Pole	EA	1	$ 1,000.00	$ 1,000.00	
Three Section Signal Head	EA	2	$ 1,000.00	$ 2,000.00	
One Section Signal Head	EA	2	$ 500.00	$ 1,000.00	Ramp meter advance signal
Signal Cable	LF	400	$ 2.75	$ 1,100.00	
Subtotal				**$ 58,307.50**	
Communications					
Serial Communications	EA	350	$ 2.00	$ 700.00	Link to MVDS
Splice Enclosure	EA	1	$ 1,000.00	$ 1,000.00	Link to SMFO
Pullbox (Special Size)	EA	1	$ 1,750.00	$ 1,750.00	For splice enclosure
Interconnect Center	EA	1	$ 1,500.00	$ 1,500.00	In cabinet
Fiber-optic Drop Cable (six strands)	LF	500	$ 1.50	$ 750.00	Drop cable to controller cabinet
Ethernet Switch	EA	1	$ 1,700.00	$ 1,700.00	
Subtotal				**$ 7,400.00**	

Pavement Marking					
Pavement Marking Removal	LF	440	$ 0.62	$ 272.80	30 mph design speed, 60' transitions, 100' narrowed lane
Raised Pavement Markers	EA	0	$ 4.50	$ -	
White Edge Line	LF	220	$ 0.95	$ 209.00	60' transitions, 100' narrowed lane
Yellow Edge Line	LF	220	$ 0.95	$ 209.00	60' transitions, 100' narrowed lane
24" Stop Bar	LF	12	$ 7.00	$ 84.00	
Subtotal				**$ 774.80**	
Signing					
W3-8, Ramp Metered When Flashing	EA	2	$ 650.00	$ 1,300.00	Sign and post only
W3-4, Be Prepared to Stop	EA	1	$ 650.00	$ 650.00	Sign and post
R10-6, Stop Here on Red	EA	1	$ 175.00	$ 175.00	Pedestal mounted
R10-28, XX Vehicles Per Green	EA	1	$ 175.00	$ 175.00	Pedestal mounted
Subtotal				**$ 2,300.00**	
Subtotal Construction (Rounded)				**$ 78,030.00**	
Traffic Control			3%	$ 3,000.00	
Contingencies			10%	$ 8,000.00	
Total Construction (Rounded)				**$ 89,030.00**	

Design	8%	$ 8,000.00
Construction Administration	10%	$ 9,000.00
Total Design and Construction		**$ 106,030.00**

Table 12. Detailed Typical Two-Lane Ramp Meter Construction Costs

Categories / Description	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork and Structures					
Retaining Wall 5' High	LF	0	$ 250.00	$ -	
Retaining Wall 10' High	LF	0	$ 475.00	$ -	
Excavation	CY	0	$ 4.00	$ -	
Fill	CY	0	$ 5.00	$ -	
Seeding	SY	1626	$ 2.50	$ 4,065.00	Seeding along pavement widening and around trench, conduit, pull box, and foundation areas
Subtotal				**$ 4,065.00**	
Guardrail					
Guardrail Rail	LF	500	$ 15.00	$ 7,500.00	
Guardrail Approach End Treatment	EA	2	$ 1,500.00	$ 3,000.00	
Subtotal				**$ 10,500.00**	
Paving					
Ramp Widening	SY	356	$ 32.00	$ 11,392.00	
Pavement Resurfacing	SY	356	$ 12.00	$ 4,272.00	
Subtotal				**$ 15,664.00**	
Drainage					
Pipe	LF	0	$ 44.00	$ -	
Subtotal				**$ -**	
Signalization					
6'x6' loops	EA	10	$ 394.50	$ 3,945.00	One queue, three passage and one clearance
Detector Lead-in Cable	EA	390	$ 1.50	$ 585.00	Assumed setback distance 350'
MVDS detector	EA	1	$ 1,800.00	$ 1,800.00	Mainline detection
Detector pole	EA	1	$ 6,000.00	$ 6,000.00	
Pullbox (Std.)	EA	6	$ 300.00	$ 1,800.00	
Conduit (Trenched)	LF	2385	$ 6.00	$ 14,310.00	All purposes
Conduit (Directional Drilled)	LF	50	$ 14.00	$ 700.00	One ramp crossing, mult. conduits
Electrical Service	EA	1	$ 1,500.00	$ 1,500.00	
Electrical Conductors	LF	1000	$ 5.00	$ 5,000.00	
2070 Controller and Cabinet	EA	1	$14,000.00	$ 14,000.00	
Firmware/Calibration	EA	1	$ 5,300.00	$ 5,300.00	
Cabinet Foundation	EA	1	$ 450.00	$ 450.00	
45' Mast Arm Poles and Foundation	EA	0	$15,000.00	$ -	
Pedestal Pole	EA	2	$ 1,000.00	$ 2,000.00	dual pedestals
Three Section Signal Head	EA	2	$ 1,000.00	$ 2,000.00	
One Section Signal Head	EA	2	$ 500.00	$ 1,000.00	Ramp meter advance signal
Signal Cable	LF	505	$ 2.75	$ 1,388.75	
Subtotal				**$ 61,778.75**	
Communications					
Serial Communications	EA	350	$ 2.00	$ 700.00	Link to MVDS
Splice Enclosure	EA	1	$ 1,000.00	$ 1,000.00	Link to SMFO
Pullbox (Special Size)	EA	1	$ 1,750.00	$ 1,750.00	For splice enclosure
Interconnect Center	EA	1	$ 1,500.00	$ 1,500.00	In cabinet
Fiber-optic Drop Cable (six strands)	LF	500	$ 1.50	$ 750.00	Drop cable to controller cabinet
Ethernet Switch	EA	1	$ 1,700.00	$ 1,700.00	
Subtotal				**$ 7,400.00**	

Pavement Marking					
Pavement Marking Removal	LF	640	$ 0.62	$ 396.80	40 mph design speed. 110' transitions, 100' narrowed lane
Raised Pavement Markers	EA	3	$ 4.50	$ 13.50	Along skip line only
White Edge Line	LF	320	$ 0.95	$ 304.00	110' transitions, 100' narrowed lane
Yellow Edge Line	LF	320	$ 0.95	$ 304.00	110' transitions, 100' narrowed lane
White Skip Line	LF	200	$ 0.24	$ 47.50	
24" Stop Bar	LF	12	$ 7.00	$ 84.00	
Subtotal				**$ 1,149.80**	
Signing					
W3-8, Ramp Metered When Flashing	EA	2	$ 650.00	$ 1,300.00	Sign and post only
W3-4, Be Prepared to Stop	EA	1	$ 650.00	$ 650.00	Sign and post
R10-6, Stop Here on Red	EA	1	$ 175.00	$ 175.00	Pedestal mounted
R10-28, XX Vehicles Per Green	EA	1	$ 175.00	$ 175.00	Pedestal mounted
W4-1L, Merge Left	EA	1	$ 650.00	$ 650.00	
Subtotal				**$ 2,950.00**	
Subtotal Construction (Rounded)				**$103,510.00**	
Traffic Control			3%	$ 4,000.00	
Contingencies			10%	$ 11,000.00	
Total Construction (Rounded)				**$118,510.00**	

Design	8%	$ 10,000.00
Construction Administration	10%	$ 12,000.00
Total Design and Construction		**$140,510.00**

Table 13. Detailed Typical Single-Lane Ramp Meter with Transit Bypass Ramp Construction Costs

Categories	Description	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork and Structures						
	Retaining Wall 5' High	LF	0	$ 250.00	$ -	
	Retaining Wall 10' High	LF	0	$ 475.00	$ -	
	Excavation	CY	0	$ 4.00	$ -	
	Fill	CY	0	$ 5.00	$ -	
	Seeding	SY	1760	$ 2.50	$ 4,400.00	Seeding along pavement widening and around trench, conduit, pull box, and foundation areas
Subtotal					**$ 4,400.00**	
Guardrail						
	Guardrail Rail	LF	500	$ 15.00	$ 7,500.00	
	Guardrail Approach End Treatment	EA	2	$ 1,500.00	$ 3,000.00	
Subtotal					**$ 10,500.00**	
Paving						
	Traffic Separator, 4' Wide	LF	200	$ 32.00	$ 6,400.00	
	Ramp Widening	SY	623	$ 32.00	$ 19,936.00	
	Pavement Resurfacing	SY	623	$ 12.00	$ 7,476.00	
Subtotal					**$ 33,812.00**	
Drainage						
	Pipe	LF	0	$ 44.00	$ -	
Subtotal					**$ -**	
Signalization						
	6'x6' loops	EA	6	$ 394.50	$ 2,367.00	One queue, three passage and one clearance
	Detector Lead-in Cable	EA	400	$ 1.50	$ 600.00	Assumed setback distance 350'
	MVDS detector	EA	1	$ 1,800.00	$ 1,800.00	Mainline detection
	Detector pole	EA	1	$ 6,000.00	$ 6,000.00	
	Pullbox (Std.)	EA	6	$ 300.00	$ 1,800.00	
	Conduit (Trenched)	LF	2385	$ 6.00	$ 14,310.00	All purposes
	Conduit (Directional Drilled)	LF	50	$ 14.00	$ 700.00	One ramp crossing, mult. conduits
	Electrical Service	EA	1	$ 1,500.00	$ 1,500.00	
	Electrical Conductors	LF	1000	$ 5.00	$ 5,000.00	
	2070 Controller and Cabinet	EA	1	$14,000.00	$ 14,000.00	
	Firmware/Calibration	EA	1	$ 5,300.00	$ 5,300.00	
	Cabinet Foundation	EA	1	$ 450.00	$ 450.00	
	45' Mast Arm Poles and Foundation	EA	0	$15,000.00	$ -	
	Pedestal Pole	EA	2	$ 1,000.00	$ 2,000.00	one on island one on left side
	Three Section Signal Head	EA	2	$ 1,000.00	$ 2,000.00	
	One Section Signal Head	EA	2	$ 500.00	$ 1,000.00	Ramp meter advance signal
	Signal Cable	LF	505	$ 2.75	$ 1,388.75	
Subtotal					**$ 60,215.75**	
Communications						
	Serial Communications	EA	350	$ 2.00	$ 700.00	Link to MVDS
	Splice Enclosure	EA	1	$ 1,000.00	$ 1,000.00	Link to SMFO
	Pullbox (Special Size)	EA	1	$ 1,750.00	$ 1,750.00	For splice enclosure
	Interconnect Center	EA	1	$ 1,500.00	$ 1,500.00	In cabinet
	Fiber-optic Drop Cable (six strands)	LF	500	$ 1.50	$ 750.00	Drop cable to controller cabinet
	Ethernet Switch	EA	1	$ 1,700.00	$ 1,700.00	
Subtotal					**$ 7,400.00**	

Pavement Marking					
Pavement Marking Removal	LF	0	$ 0.62	$ -	To narrow lanes, 40 MPH, maintain one edge line, pave over other edge line
Raised Pavement Markers	EA	6	$ 4.50	$ 27.00	Along skip line only and both sides of median
White Edge Line	LF	980	$ 0.95	$ 931.00	To narrow lanes, 40 MPH, 190' transition
Yellow Edge Line	LF	580	$ 0.95	$ 551.00	To narrow lanes, 40 MPH, 190' transition
24" Stop Bar	LF	24	$ 7.00	$ 168.00	
White Skip Line	LF	0	$ 0.24	$ -	
Bus Message	EA	3	$ 510.00	$ 1,530.00	
Diamond Symbol	EA	3	$ 120.00	$ 360.00	
Subtotal				**$ 3,567.00**	
Signing					
W3-8, Ramp Metered When Flashing	EA	2	$ 650.00	$ 1,300.00	Sign and post only
W3-4, Be Prepared to Stop	EA	1	$ 650.00	$ 650.00	Sign and post
R3-11b, Buses Only	EA	3	$ 300.00	$ 900.00	
R10-6, Stop Here on Red	EA	1	$ 175.00	$ 175.00	Pedestal mounted
R10-28, XX Vehicles Per Green	EA	1	$ 175.00	$ 175.00	Pedestal mounted
W4-1L, Merge Left	EA	1	$ 650.00	$ 650.00	
Subtotal				**$ 3,850.00**	
Subtotal Construction (Rounded)				**$ 123,750.00**	
Traffic Control			3%	$ 4,000.00	
Contingencies			10%	$ 13,000.00	
Total Construction (Rounded)				**$ 140,750.00**	

Design	8%	$ 12,000.00
Construction Administration	10%	$ 15,000.00
Total Design and Construction		**$ 167,750.00**

Table 14. Detailed Typical Single-Lane Freeway-to-Freeway Ramp Meter Construction Costs

Categories / Description	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork and Structures					
Retaining Wall 5' High	LF	0	$ 250.00	$ -	
Retaining Wall 10' High	LF	0	$ 475.00	$ -	
Excavation	CY	0	$ 4.00	$ -	
Fill	CY	0	$ 5.00	$ -	
Seeding	SY	2122	$ 2.50	$ 5,305.00	Seeding around trench, pull box, conduit, and foundation areas
Subtotal				**$ 5,305.00**	
Guardrail					
Guardrail Rail	LF	1500	$ 15.00	$ 22,500.00	
Guardrail Approach End Treatment	EA	6	$ 1,500.00	$ 9,000.00	
Subtotal				**$ 31,500.00**	
Drainage					
Pipe	LF	0	$ 44.00	$ -	
Subtotal				**$ -**	
Signalization					
6'x6' loops	EA	5	$ 394.50	$ 1,972.50	One queue, three passage and one clearance
Detector Lead-in Cable	EA	390	$ 1.50	$ 585.00	Assumed setback distance 350'
MVDS detector	EA	1	$ 1,800.00	$ 1,800.00	Mainline detection
Detector pole	EA	1	$ 6,000.00	$ 6,000.00	
Pullbox (Std.)	EA	10	$ 300.00	$ 3,000.00	
Conduit (Trenched)	LF	3110	$ 6.00	$ 18,660.00	All purposes
Conduit (Directional Drilled)	LF	50	$ 14.00	$ 700.00	One ramp crossing, mult. conduits
Electrical Service	EA	1	$ 1,500.00	$ 1,500.00	
Electrical Conductors	LF	1000	$ 5.00	$ 5,000.00	
2070 Controller and Cabinet	EA	1	$14,000.00	$ 14,000.00	
Firmware/Calibration	EA	1	$ 5,300.00	$ 5,300.00	
Cabinet Foundation	EA	1	$ 450.00	$ 450.00	
45' Mast Arm Poles and Foundation	EA	1	$15,000.00	$ 15,000.00	
Pedestal Pole	EA	0	$ 1,000.00	$ -	
Three Section Signal Head	EA	2	$ 1,000.00	$ 2,000.00	
One Section Signal Head	EA	6	$ 500.00	$ 3,000.00	Ramp meter advance signal
Signal Cable	LF	1386	$ 2.75	$ 3,811.50	
Subtotal				**$ 82,779.00**	
Communications					
Serial Communications	EA	350	$ 2.00	$ 700.00	Link to MVDS
Splice Enclosure	EA	1	$ 1,000.00	$ 1,000.00	Link to SMFO
Pullbox (Special Size)	EA	1	$ 1,750.00	$ 1,750.00	For splice enclosure
Interconnect Center	EA	1	$ 1,500.00	$ 1,500.00	In cabinet
Fiber-optic Drop Cable (six strands)	LF	500	$ 1.50	$ 750.00	Drop cable to controller cabinet
Ethernet Switch	EA	1	$ 1,700.00	$ 1,700.00	
Subtotal				**$ 7,400.00**	
Pavement Marking					
Pavement Marking Removal	LF	1000	$ 0.62	$ 620.00	50 MPH design speed, 200' transitions, 100' narrowed lane
Raised Pavement Markers	EA	0	$ 4.50	$ -	
White Edge Line	LF	500	$ 0.95	$ 475.00	200' transitions, 100' narrowed lane, 50 MPH
Yellow Edge Line	LF	500	$ 0.95	$ 475.00	200' transitions, 100' narrowed lane, 50 MPH
24" Stop Bar	LF	12	$ 7.00	$ 84.00	Maintain existing skip
Subtotal				**$ 1,654.00**	

Signing					
W3-8, Ramp Metered When Flashing	EA	2	$ 650.00	$ 1,300.00	Sign and post only
W3-4, Be Prepared to Stop	EA	1	$ 650.00	$ 650.00	Sign and post
R10-6, Stop Here on Red	EA	1	$ 175.00	$ 175.00	Pedestal mounted
R10-28, XX Vehicles Per Green	EA	1	$ 175.00	$ 175.00	Pedestal mounted
Sign Structure (Cantilever)	EA	2	$50,000.00	$ 100,000.00	
Ramp Meter On Sign (Message A)	EA	1	$ 5,000.00	$ 5,000.00	
Prepare to Stop Sign (Message B)	EA	1	$ 5,000.00	$ 5,000.00	
Subtotal				**$ 112,300.00**	
Subtotal Construction (Rounded)				**$ 240,940.00**	
Traffic Control			3%	$ 8,000.00	
Contingencies			10%	$ 25,000.00	
Total Construction (Rounded)				**$ 273,940.00**	

Design	8%	$ 22,000.00
Construction Administration	10%	$ 28,000.00
Total Design and Construction		**$ 323,940.00**

Table 15. Detailed Typical Two-Lane Freeway-to-Freeway Ramp Meter Construction Costs

Categories	Description	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork and Structures						
	Retaining Wall 5' High	LF	0	$ 250.00	$ -	
	Retaining Wall 10' High	LF	0	$ 475.00	$ -	
	Excavation	CY	0	$ 4.00	$ -	
	Fill	CY	0	$ 5.00	$ -	
	Seeding	SY	2255	$ 2.50	$ 5,637.50	Seeding along pavement widening and around trench, conduit, pull box, and foundation areas
Subtotal					**$ 5,637.50**	
Guardrail						
	Guardrail Rail	LF	1500	$ 15.00	$ 22,500.00	
	Guardrail Approach End Treatment	EA	6	$ 1,500.00	$ 9,000.00	
Subtotal					**$ 31,500.00**	
Paving						
	Traffic Separator, 4' Wide	LF	0	$ 32.00	$ -	
	Ramp Widening	SY	356	$ 32.00	$ 11,392.00	
	Pavement Resurfacing	SY	356	$ 12.00	$ 4,272.00	
Subtotal					**$ 15,664.00**	
Drainage						
	Pipe	LF	0	$ 44.00	$ -	
Subtotal					**$ -**	
Signalization						
	6'x6' loops	EA	10	$ 394.50	$ 3,945.00	One queue, three passage and one clearance
	Detector Lead-in Cable	EA	390	$ 1.50	$ 585.00	Assumed setback distance 350'
	MVDS detector	EA	1	$ 1,800.00	$ 1,800.00	Mainline detection
	Detector pole	EA	1	$ 6,000.00	$ 6,000.00	
	Pullbox (Std.)	EA	10	$ 300.00	$ 3,000.00	
	Conduit (Trenched)	LF	3110	$ 6.00	$ 18,660.00	All purposes
	Conduit (Directional Drilled)	LF	50	$ 14.00	$ 700.00	One ramp crossing, mult. conduits
	Electrical Service	EA	1	$ 1,500.00	$ 1,500.00	
	Electrical Conductors	LF	1000	$ 5.00	$ 5,000.00	
	2070 Controller and Cabinet	EA	1	$14,000.00	$ 14,000.00	
	Firmware/Calibration	EA	1	$ 5,300.00	$ 5,300.00	
	Cabinet Foundation	EA	1	$ 450.00	$ 450.00	
	45' Mast Arm Poles and Foundation	EA	1	$15,000.00	$ 15,000.00	
	Pedestal Pole	EA	0	$ 1,000.00	$ -	
	Three Section Signal Head	EA	2	$ 1,000.00	$ 2,000.00	
	One Section Signal Head	EA	6	$ 500.00	$ 3,000.00	Ramp meter advance signal
	Signal Cable	LF	1386	$ 2.75	$ 3,811.50	
Subtotal					**$ 84,751.50**	
Communications						
	Serial Communications	EA	350	$ 2.00	$ 700.00	Link to MVDS
	Splice Enclosure	EA	1	$ 1,000.00	$ 1,000.00	Link to SMFO
	Pullbox (Special Size)	EA	1	$ 1,750.00	$ 1,750.00	For splice enclosure
	Interconnect Center	EA	1	$ 1,500.00	$ 1,500.00	In cabinet
	Fiber-optic Drop Cable (six strands)	LF	500	$ 1.50	$ 750.00	Drop cable to controller cabinet
	Ethernet Switch	EA	1	$ 1,700.00	$ 1,700.00	
Subtotal					**$ 7,400.00**	

Pavement Marking					
Pavement Marking Removal	LF		$ 0.62	$ -	To narrow lanes, 50 MPH design speed, maintain one edge line, pave over other edge line
Raised Pavement Markers	EA	3	$ 4.50	$ 13.50	Along skip line only
White Edge Line	LF	600	$ 0.95	$ 570.00	200' transitions, 100' narrowed lane, 50 MPH
Yellow Edge Line	LF	600	$ 0.95	$ 570.00	300' transitions, 100' narrowed lane, 50 MPH
24" Stop Bar	LF	24	$ 7.00	$ 168.00	
White Skip Line	LF	200	$ 0.24	$ 47.50	
Subtotal				**$ 1,369.00**	
Signing					
W3-8, Ramp Metered When Flashing	EA	2	$ 650.00	$ 1,300.00	Sign and post only
W3-4, Be Prepared to Stop	EA	1	$ 650.00	$ 650.00	Sign and post
R10-6, Stop Here on Red	EA	1	$ 175.00	$ 175.00	Pedestal mounted
R10-28, XX Vehicles Per Green	EA	1	$ 175.00	$ 175.00	Pedestal mounted
W4-1L, Merge Left	EA	2	$ 650.00	$ 1,300.00	
Sign Structure (Cantilever)	EA	2	$50,000.00	$ 100,000.00	
Ramp Meter On Sign (Message A)	EA	1	$ 5,000.00	$ 5,000.00	
Prepare to Stop Sign (Message B)	EA	1	$ 5,000.00	$ 5,000.00	
Subtotal				**$ 113,600.00**	
Subtotal Construction (Rounded)				**$ 259,930.00**	
Traffic Control			3%	$ 8,000.00	
Contingencies			10%	$ 26,000.00	
Total Construction (Rounded)				**$ 293,930.00**	

Design	8%	$ 24,000.00
Construction Administration	10%	$ 30,000.00
Total Design and Construction		**$ 347,930.00**

Table 16. Detailed Typical Optional Enforcement Features Construction Costs

Categories / Description	Unit	Quantity	Unit Cost	Total Cost	Assumptions
Earthwork and Structures					
Retaining Wall 5' High	LF	0	$ 250.00	$ -	
Retaining Wall 10' High	LF	0	$ 475.00	$ -	
Subtotal				**$ -**	
Guardrail					
Guardrail Rail	LF	0	$ 15.00	$ -	
Guardrail Approach End Treatment	EA	0	$ 1,500.00	$ -	
Subtotal				**$ -**	
Paving					
Excavation	CY	0	$ 4.00	$ -	
Fill	CY	188	$ 5.00	$ 940.00	
Seeding	SY	25	$ 2.50	$ 62.50	Seeding along edge of pavement
Subtotal				**$ 1,002.50**	
Paving					
Ramp Widening	SY	188	$ 32.00	$ 6,016.00	
Pavement Resurfacing	SY	0	$ 12.00	$ -	
Subtotal				**$ 6,016.00**	
Signalization					
One Section Signal Head	EA	1	$ 500.00	$ 500.00	
Signal Cable	LF	10	$ 2.75	$ 27.50	Enforcement signal
Subtotal				**$ 527.50**	
Pavement Marking					
Raised Pavement Markers	EA	0	$ 4.50	$ -	
White Edge Line	LF	330	$ 0.95	$ 313.50	
Subtotal				**$ 313.50**	
Signing					
Enforcement Area Sign	EA	1	$ 650.00	$ 650.00	Sign and post only
Subtotal				**$ 650.00**	
Subtotal Construction (Rounded)				**$ 8,510.00**	
Traffic Control			3%	$ 1,000.00	
Contingencies			10%	$ 1,000.00	
Total Construction (Rounded)				**$ 10,510.00**	

Design	8%	$ 1,000.00
Construction Administration	10%	$ 2,000.00
Total Design and Construction		**$ 13,510.00**

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